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Trench Machines

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TRENCH MACHINES

BY

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

ALFRED GEORGE SCHUTT

ENTITLED TRENCH MACHINES

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Civil Engineering

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TRENCH MACHINES

Introduction.

The excavation and handling of earth by manual labor is a slow and laborious process. This is especially true in the construction of trenches for sewer, water and gas mains, etc., the excavation of which by hand usually requires that the trench be wide enough to permit the laborers to handle their tools, thus necessitating the removal of more material than would actually be needed for the purposes of the trench. This is most notable in deep trenches, where the material must be handled several times in passing it up on staging. Further, as sewer and other trenches are usually located in public thoroughfares, the speedy and proper excavation and refilling of them is a matter of much concern to local residents and others desiring to use the

street. For these reasons, as well as for increased economy, machines have been devised to excavate these trenches and handle the material.

Many kinds of trench machines have been built, and more have been "invented"; but only a few have survived the ordeal of a practical test. It is the purpose of this paper to describe and discuss the various types of this select few.

According to their purposes, trench machines may be divided into three classes, viz:-

I. Machines which only convey the material from the point of excavation back to the point where it is dumped into the completed trench.

II. Machines which only excavate the material, and deposit it on the sides of the trench.

III. Machines which combine the above two operations, handling as well as excavating the material.

For convenience these will be termed as follows:-

I. Conveying Machines.

II. Excavating Machines.

III. Excavating and Backfilling Machines.

I. Conveying Machines.

Undoubtedly the first trench machine made was some sort of conveying machine; and this form continues to be used more extensively than any other. Machines for conveying the excavated material may be subdivided into three types: (a) the traveling derrick, (b) the cableway, and (c) the tramway.

a. Traveling Derrick.

The traveling derrick, or locomotive crane, is probably the pioneer of trench machines. It consists simply of a derrick and a hoisting engine mounted on a small car, the hoisting engine serving also as the power for moving the car along a track. The track may be either astraddle of the trench or on one side, the latter seeming to be preferred. As the locomotive crane is easily adaptable for almost any hoisting work, and is not strictly confined to trench excavation, it will not be further considered. An ex-

cellent type, as made by the American Hoist and Derrick Co., of St. Paul, Minn., is shown in Fig. 1.

Fig. 1.

b. Cableway.

This must be arranged over the trench so as to interfere as little as possible with the prosecution of the work, and also so as to

offer the least obstruction to travel. The only form of cableway applied to trench work is made by the Carson Trench Machine Co., of Boston, Mass.; and is called the Carson-Lidgerwood Cableway. It consists simply of a steel cable securely anchored at both ends, and elevated over the centre-line of the trench by towers 20 to 35 feet in height which are placed from 200 to 300 feet apart, the span depending usually on the amount of trench which can be opened at once. The bucket, or tub for carrying the material, travels on a trolley along this cable. The carriage is connected with a double-drum hoisting engine located at one end of the cableway. The general arrangement is indicated in Fig. 2.

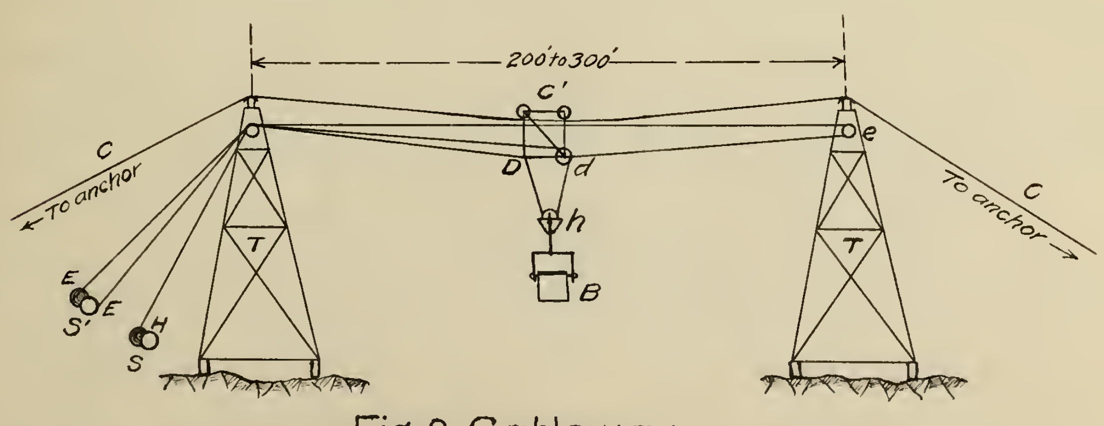


Fig. 2. Cableway.

CC is the steel cable which supports the carriage C' and guides it in the horizontal motion communicated by the endless rope EeE. This rope is attached to the carriage at the points D and d, and passes over the spool S' of the hoisting engine. The hoisting-rope Hh is attached at D and passes over the spool S of the engine. At h this rope passes over a sheave to which is attached the material bucket B. The bucket is brought to a position directly over the center of excavation in the trench, by the endless rope, and is then lowered into the trench by means of the hoisting rope, where another bucket has already been filled by hand. The full bucket is raised to the desired height, is rapidly transported to the completed portion of the work, and is there dumped. The speed of hoisting a loaded 1-yard bucket weighing about 5,000 pounds, is about 250 per minute; while the speed of conveying the same is about 400 ft. per minute. The output depends, of course, "on the number of men digging, and the character of the material;" but, using 4,1-yard

buckets, the capacity as given by the manufacturer is 450 cu. yds. in 10 hours; tho' 40 cu. yds. per hour may be taken as an average. The cost per cu. yd. will vary from 10 to 25 cents, with 20¢ as an average rate, exclusive of the cost of sheeting and bracing, of depreciation of plant, etc. The use of this machine, however, is not deemed economical for trenches less than 8 feet deep.

Some of the advantages of the Cableway System are:

1. Earth is handled but once.

2. Greater amount of material excavated with a given number of men, as no more are required to excavate a trench 30 feet than one 8 feet deep.

3. Material is not piled on sides of trench, and as the weight of the towers is small, the danger of caving is reduced to a minimum.

4. Very little obstruction is offered to travel.

5. The machine can be advantageously used in raising and lowering heavy materials, such as iron pipes, rock drills, etc.

6. It is adapted for use in any material,

being especially valuable when water or soft earth is encountered. Fig. 3 is an illustration of a Carson-Lidgerwood Cableway, and shows very well, how little the street is obstructed by it.

Fig. 3.

c. Tramways.

The machines of this type are the "Carson", the "Potter", the "Moore", and the "Adams". These will be taken up in order.

The Carson Machines.

There are two general forms of the Carson machine, termed the Carson Trench Machine and the Carson-Trainor Hoister and Conveyor. In both forms the principles of operation are the same as in the cableway described above, the difference between them being that the guide-cable of the latter is replaced by a rigid track supported over the trench by trestle bents. The track consists usually of two channels riveted together to form an I, the carriages running on the lower flanges. Sometimes two lines of Is are used, each carring several buckets. The trestle bents are made of stout timbers well braced. The shape of trestle bents differs in the two forms of the Carson machine. In the Carson-Trainor Hoister and Conveyor the trestle is A shaped, and supports only a single track; while in the Carson Trench Machine the

trestle is of a rectangular form, and may carry either a single or a double track. Both machines have a working section 288 feet long, the number of trestles varying from eleven to eighteen. Both are mounted on small wheels or castors, and can be easily and quickly moved ahead. The A frames possess the advantage of being absolutely rigid; while the rectangular shape must be securely braced against high winds. In addition to having all the advantages enumerated for the cableway, the trestle machines do not require to be heavily anchored nor to have any towers reset each time the machine is moved. The cableway can be used for trenches of any depth or width, but it is not recommended to use the Carson machine for a greater width than 12 feet or the Carson-Trainor machine for more than 20 feet.

The manufacturers of the Carson machines give the following regarding the capacity of their machines: "The progress of the job depends mainly upon the skill with which the work is prosecuted, but also upon the ability of those who

use the machine to keep it in good order; and probably but $\frac{1}{2}$ or $\frac{1}{3}$ of the daily capacity of the machine will be realized continuously." The number of 1-yard tubs used varies from 4 to 24, depending on whether the machine is single or double track. The average time per trip of a tub is about 1 min. 20 secs., while the output may vary from 10 to 40 cu. yds. per hour, with a cost per yard ranging from 15¢ to 80¢, exclusive of sheeting, pumping, etc.

All of the Carson machines are leased for about \$200.^{00} to \$250.^{00} per month with engine complete, and may be bought for about \$3000.^{00} to \$4000.^{00}.

On the following page, Fig. 4 is an illustration of the double track Carson Trench Machine, and Fig. 5 of the Carson-Trainor Hoister and Conveyor.

Fig. 4.

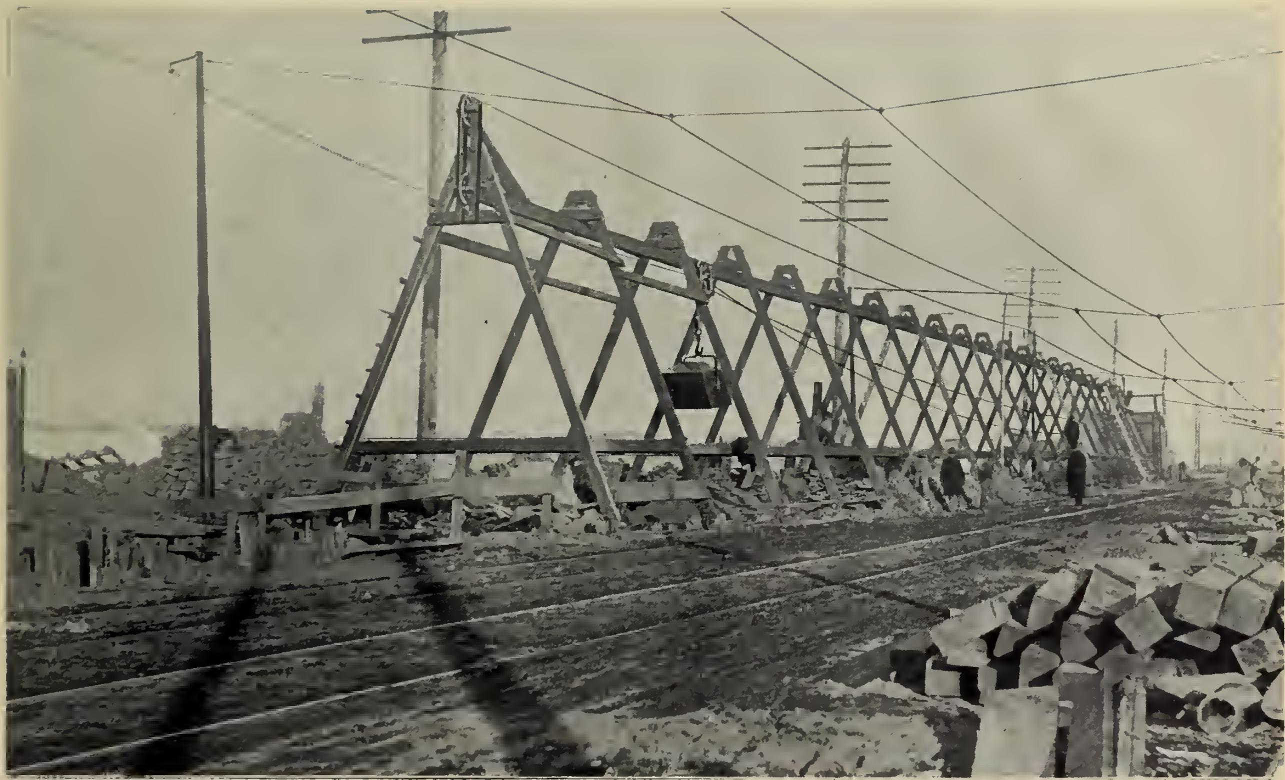


Fig. 5.

The Potter Machine.

In the Potter machine, the conveying device consists of a platform car running on a steel trestle. As shown in Figs. 6 and 7, the essential difference between this and the other machines described above, lies in the car and its mechanism. Referring to Fig. 6, the upper cable, or traveling rope, starts from a drum

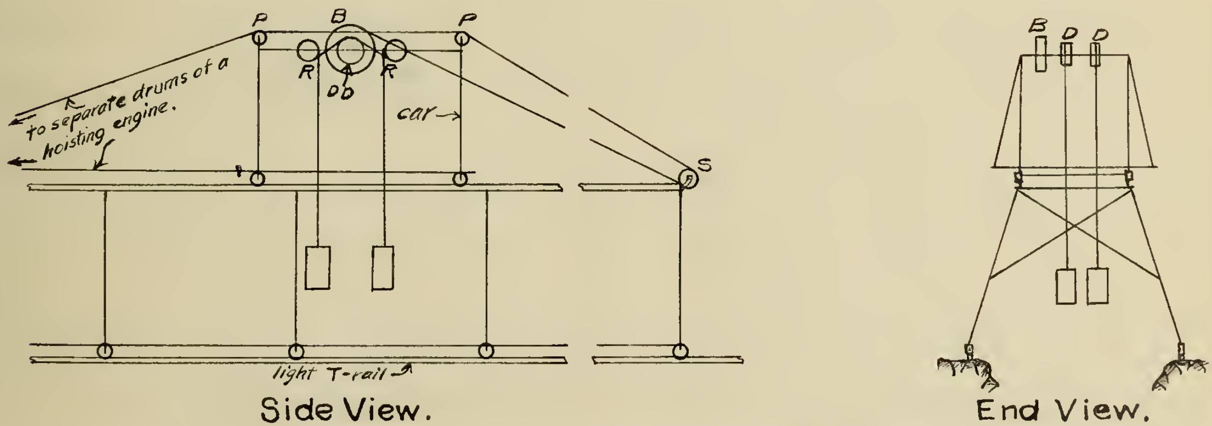


Fig. 6. Outline of the Potter Machine.

of the hoisting engine located at one end of the trestle, passes up and over the pulleys PP on the car, thence around a sheave S at the rear end of the trestle, and back again to the car, where it passes around a "bull-wheel" B to which it is attached. On the same shaft with this bull-wheel, are two drums DD on which are wound the

hoisting ropes. The buckets attached to the hoisting ropes are raised or lowered by winding or unwinding the main cable on the bull-wheel. Two buckets are hoisted at once, and these are kept well apart by having the hoisting ropes running over separate pulleys RR placed on opposite sides of the main drum. A second cable is attached to the front end of the car, and serves to hold the car in position while the buckets are being hoisted, and also to pull it forward when they have been dumped. When the filled buckets have been hoisted to clear all sheathing etc., the bull-wheel is locked, and the main cable continues to be wound up by the hoisting engine, while the second cable is unwound at the same rate of speed, thus pulling the car to the dumping point. The buckets are made with capacities of $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{4}$ or 1 cu. yd.; and the manufacturers claim that two buckets of any one these sizes may be lowered and hoisted, and the car run back and forth, in one minute. While being conveyed, the buckets are securely locked in place by a ratchet and pawl on the main shaft. ~~Like~~ Like the others, this

machine is also mounted entirely on wheels which run on a track laid astraddle of the trench, as seen in Fig. 7. On the Chicago Intercepting Sewer work, the machine was moved ahead at a rate of about 50 feet in 5 minutes, and handled from 50 to 60 cu. yds. of earth per hour.* The entire length of a machine is about 300 feet, and has a span of about 10 feet, tho' this can be altered for different widths of trench.

Another form of this machine is also made by the Potter Mfg. Co. for use on short trenches, or where there are many curves in the alignment. They call this their "Surface Track Machine". The car, instead of running on a trestle, runs on a track laid directly on the ground, but is set high enough on its wheels so as to clear projecting planks, etc. The Potter machine is probably best adapted for use in deep trenches, say greater than 10 feet, where the material is soft or sandy so that excavation is easy. The machines are usually not sold, but are leased by the makers.

* Jour. West. Soc. Engrs. Vol. 10, p. 67. & "The Contractor" of 1-15-'02.

for about $200.00 per month, hoisting engine not included, and the lessees to employ the operatives. Four men are required to operate the machine, viz: 1 engineman, 1 fireman, and 2 carriermen. The carriermen are always on the car, and herein lies an advantage, as they command a full view of the work and can thus act as signalmen at both starting and stopping points. It would seem to the writer that the machine could not well be used on a street having many overhanging trees without injuring the latter or causing considerable delay in the travel of the carriage, as the height to top of car is about 20 feet. Another objectionable feature is that it would be quite natural for the men in the trench to glance upward as the car passed overhead, thus losing some time, — truly, only an instant perhaps, but 1000 "instants" per day, for, say 5 or 10 men would undoubtedly be easily noticeable in a month's output, especially if the men were brick layers working at $1.00 to $1.50 per hour.

Fig. 7.

The Moore Trench Machine.

The Moore Trench Machine is quite similar in construction and operation to the Potter machine, differing principally in the mechanical features of the hoisting device on the traveling car. The output claimed by the makers, The Moore Mfg. Co. of Buffalo, N.Y., is 800 cu. yds. per day; but on some extensive sewer

construction at Peoria, Ill., in 1896, the average number of 1-yard buckets handled per day was 286, in a 12 ft. x 35 ft. trench, at an average cost of 13.3¢ per yard. On account of its similarity to the Potter machine, described above, the Moore machine will not be discussed further.

The Adams Trench Machine.

This machine was first used in 1896 at Peoria, Ill., and was invented by Adams Bros. who were engaged on that work. The general principles of construction and operation of the Adams machine are much the same as those of the Carson Trench Machine, and hence will be only briefly discussed. The trestle bents are ∩ shaped and are made of wrought iron. Just below the top of the bents a T-rail is supported on each side of the trench by a steel gusset plate attached to the legs of the bent. On this track runs the bucket, operated by a cable attached to a hoisting engine at one end of the work. The bents

are about 16 feet high, have a span at the bottom of about 14 feet and are spaced about 18 feet centre to centre. As in the Carson machine, the bents are mounted on small wheels running on rails, so that the entire machine is easily moved ahead.

Two of these machines were used on the work at Peoria. With the first one made, the average output was 288 yds. per day on a 12 ft. x 33 ft. trench, at a cost of 12½¢ per yd. With the improved Adams machine on a 13 ft. x 45 ft. trench, the cost per cu. yd. was decreased to 11.4¢ and the output increased to 316 cu. yds. per day. The latter form of machine was arranged to carry a travelling steam hammer for driving the sheeting, and also a device for pulling the latter. By this means a saving of 92¢ per lineal foot was secured as compared with driving and pulling the sheeting by hand.

II. Excavating Machines.

This type represents the most recent improvements in trench machines. It has been only within the last ten or twelve years that trench excavators have been used, while some of the conveying machines described, have been in use for twenty or thirty years. Excavating machines then may be said to be still in their infancy; and it this class of trench machinery under which the largest number of failures may be listed. The problem of merely conveying earth which has been excavated by hand, is quite simple in comparison with that of the excavation itself, for any kind of earth can be carried in the buckets, while the character of the material must be carefully considered when an excavating machine is to be employed. The excavating machines which are in use at present are: "The Chicago Sewer Excavator", the "Buckeye Traction Digger", the "Libbe Digging Machine," and the "Stephens Excavating, Elevating and Delivering Machine". The patents for the last were applied

for only in December 1904.

The Chicago Sewer Excavator.

This machine is built by the Municipal Engineering and Contracting Co. of Chicago, and is one which has satisfactorily passed the experimental stage. As seen in Figs. 8 to 14, the machine is self-contained and has four distinct parts, viz: the boiler, the engine, the cutter, and the conveyor.

The boiler is of the ordinary vertical fire-tube variety, with a "swell-top" to provide the maximum heating surface; and is about 40 H.P. The engine is a simple horizontal one of about 30 H.P. The cutter beam is the principal feature of this machine, and may be described as follows: two steel 10- to 12-inch channels, 20 feet long connected by plates and cross-braces, form the body of the beam. At each end are attached two hexagonal sprocket wheels, around which passes a pair of endless link-belt chains, the links being steel drop-forged and about 12 inches long by 4 inches wide. At the upper end of the beam

the sproket wheels are attached to a shaft to which motion from the engine is communicated by a system of gear wheels. At intervals of from 4 to 7 feet (depending on the width of trench) the chains are connected by cross bars, each carrying from three to four steel cutters and a small steel apron which acts as a scoop. These cutters are staggered on successive bars so that the working face will be uniformly cut. Cutters of a special shape for trimming the sides of the trench, are placed on the ends of alternate bars. The beam is forced against the working face of the trench by means of the vertical frame attached to it and also by its own weight. The frame is provided with rack and pinion, (see illustrations) by which the beam is raised or lowered, thus regulating the depth of cut. As the material is loosened by the cutters, it is caught by the scoops or aprons, and is carried by the latter to the top of the beam and there thrown onto a belt conveyor which discharges the material along the side of the trench. If it is desired to remove the earth

as it is excavated, the conveyor may discharge into wagons driven alongside of the machine, or even onto another belt conveyor about 80 feet long and 4 feet wide, which will deposit the material in the completed trench. This conveyor is, however, still an experiment; but ought to prove a valuable attachment. A separate engine, which may be supplied with steam from the machine boiler, furnishes the power. A mechanical feature of the aprons or carriers, is that they are hinged, and as they pass over the sprocket wheels at the upper end of the beam, they are given a slight flip which projects the material onto the conveyor and prevents it from clinging to the cutters. The entire machine, being mounted on broad tired wheels, pulls itself ahead by means of a cable winding on a drum and attached at the other end to a "dead man" some 300 to 500 feet away. The rate of winding, which is also the rate of cutting, is regulated by a ratchet wheel driven by an eccentric-rod. This rate of speed is adjustable, a "feed" of one notch on the ratchet wheel being a rate of about 20 feet an hour,

and three notches, about 60 feet an hour, being the speed most used.

Since the machine is supported on the surface in advance of the open cut, it is claimed by the makers that it exerts no weight whatever on the sides of the trench. But the writer has known of at least one instance where this did not apparently hold true, for the sides would cave in almost immediately after the trench had been excavated and before the sheathing could be placed. The total weight of the machine is about 30 tons, with more than two-thirds of this concentrated on the wheels nearest the trench; and hence the caving was probably caused by the shearing off of the material adjacent to the trench, due to the great pressure brought ~~to bear~~ to bear upon it. The soil in this case was a slightly sandy loam but stood well when excavated by hand. It is surprising that the above is not of more frequent occurrence, when we consider that the large wheels are only about 3 feet from the edge of a 36-inch trench, tho' of course slightly in advance of the open cut.

Another case of similar nature is known to the writer. A heavy rain softened the ground around the machine, which settled 4 feet, causing the adjacent sides of the trench to cave in. Four days were consumed in raising the machine and cleaning out the trench! In this instance the material was good stiff clay.

The machine is not at all fit for use in very wet soil or in solid rock, the "ideal" material being stiff clay, tho' shale is very easily excavated by it but is hard on the teeth or "spuds." In wet material it is best to have the cutter as nearly horizontal as possible, and in hard material, as nearly vertical as possible. In fact in the latter, the machine works more economically as the position of the cutter beam approaches the vertical, due to the fact that the cutters pass over less surface for the same depth, thus affecting a saving in fuel and water, as well the wear on the machine parts. In this connection, it may be interesting to note that on a certain piece of sewer excavation, con-

siderable water and mud was encountered in a deep trench, and that straw was thrown into the bottom of it to act as a binder. In this way the soft material was successfully elevated with only a slight additional cost for the straw. The makers of this machine claim that it will ordinarily excavate from 400 to 500 feet per day, but on some extensive work at Danville, Ill., the maximum was 400 feet in an 8½-foot by 32-inch trench or about 340 cu. yds.; while in a 15 by 5 foot trench the maximum length was 132 feet or about 370 cu. yds. per day. The average cost of operation is about \$45.00 per day. The machine is not usually sold, but is leased for about \$30.00 per day with an additional charge for each cubic yard excavated. For all excavation beyond a depth of 10 feet, this charge per cu. yd. is about twice what it is for excavation less than 10 feet.

In narrow streets or alleys, the machine can not be used, as its width with carrier extended 5 feet on both sides is about 20 feet,

leaving no room for depositing the material. Nor can it be used where the sewer is placed in the parking, on account of trees, poles, etc. Service water and gas pipes in the line of the trench, must be removed ahead of the machine, tho' it will easily cut a 2 inch pipe. When boulders are encountered the cutter is raised slightly, and the boulder removed by hand if large. Small stones occassion much trouble by lodging between the sprocket wheel and chain at the bottom end, and very often break a link in the chain. The use of this machine is not advised for any excavation less than 8 or 10 feet, but has proved very economical for greater depths, the maximum possible with the present machines being about 20 feet.

Fig. 8.

Fig. 9.

Fig. 10.

Showing method of sheeting in deep trench behind excavator.

Fig. 11.

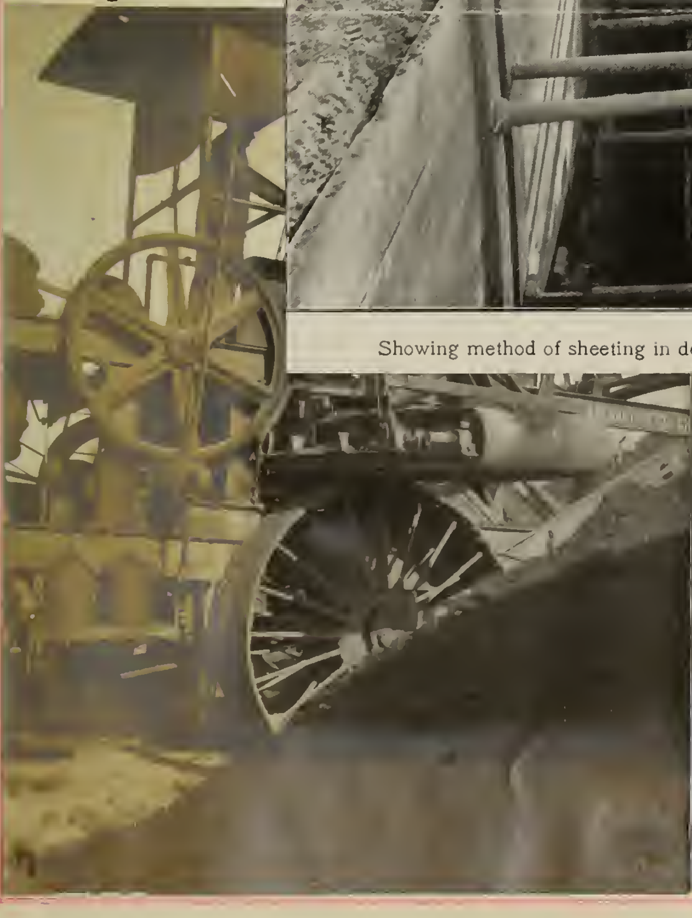


Fig. 12.

Fig. 13.

Fig. 14.

The Buckeye Traction Digger.

This machine was invented by Mr. James B. Hill of Ohio, about 1895, and was originally intended to facilitate the laying of farm drain tiles. It is now, however, used for digging sewer as well as drainage trenches. Thirty-six different sizes of this machine are made in two types: thirteen tile-drainage machines, and twenty-three sewer machines.

As seen in Figs. 15 and 17, the excavating device of this machine consists essentially of a wheel carrying a number of bucket scoops attached to its periphery. The wheel proper consists of two circular rims held together, at the proper distance from each other, by the steel "bucket-backs" which are rigidly riveted in place; over these are semi-circular steel hoods or "bucket-tops" which hold the earth cut loose by the cutters. There are two series of cutters, the one which cuts the center, and one which trims the sides of the trench. The "center cutters" are simply the prolonged and hardened edge of the hoods; and the "side

cutters are flaring teeth attached to each end of the "center cutter" and slightly in advance of the latter. The wheel has no central shaft but is supported on a stationary spoke-like frame which has small rollers at the outer ends of the spokes. On the outside edges of the circular rims are teeth which engage in sprocket wheels. The latter are driven by an engine mounted on the machine, and cause the cutting wheel to revolve. The entire machine is mounted on a traction gear and propells itself without the use of an anchored cable, such as is needed with other excavating machines.

In starting a trench, the cutting wheel is lowered into the ditch which has been previously opened by hand, and is then caused to revolve. The cutters loosen the earth, which is scooped up by the buckets and carried around to the top of the wheel. Just after passing the top, these buckets empty onto a belt conveyor which is located just under the upper arc of the wheel rim, and the material is deposited on the sides of the trench.

a notable advantage of the circular form of the cutters and buckets, is that they cut a round-bottomed trench, thus leaving a solid foundation for the curved inverts of pipe or brick sewers. As in the other excavating machines, the weight of this one is supported in advance of the open trench. The "Buckeye" is, however, considerably lighter than any of the other machines described, weighing probably about 8 or 10 tons.

This machine will excavate almost any material except solid rock; but the greatest depth possible with the largest size is only about 12 feet, the width varying from 11½ to 54 inches in the different sizes. The speed claimed is from 8 to 20 rods per hour in "ordinary" earth, according to the depth. Further, that the large machines (presumably a 24-inch) have cut 11 feet of trench 3½ feet deep in "loose earth", in one minute, or about 170 cu. yds. per hour! As the makers themselves say, "this sounds large"; but they are apparently willing to prove the statement. The writer has discussed this ma-

chine with contractors who have seen it operate, and the general opinion seems to be that it is a very successful excavator.

Fig. 15.

Fig. 16.

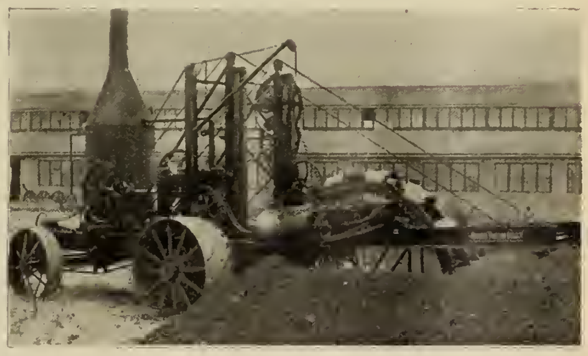


Fig. 17.

The Stephens Excavating, Elevating, and Delivering Machine.

This is the most recent type of trench machine, the patents having been applied for only a few months ago. (April 1905.)

In this machine an attempt is made to combine the principles of a steam shovel and an endless-chain and bucket dredge. As seen in the illustration, Fig. 18, a beam about 12 feet long has a toothed scoop at its outer end, and also carries a ladder of buckets. The scoop is drawn upward against the working face of the excavation, and the material is forced into a collecting "boot", through which the elevating buckets pass. As the latter go thro' the boot they pick up the material and elevate it to the upper end of the beam, where the material is dumped onto a belt conveyor, which deposits it on the sides of the trench. By attaching flaring blades to the sides of the shovel, a trench 36 inches wide may be cut, but ordinarily three cuts of 12 inches each would be made. This is accomplished by having two platforms, the upper of which

works transversely on the lower. The upper platform carries the hoisting engine which furnishes the power for all purposes, i.e., that of cutting, and also of propelling the entire machine. In Fig. 18, the cutter is seen at the end of beam next to the engine carriage. In beginning the work, this end is swung out as far as possible from the engine by raising the controlling boom. Then the latter is lowered until the scoop will cut the surface when the cable attached to the cutting beam is hauled in. As this operation is repeated the machine pulls itself forward until the required depth is secured. Or, the first excavation may be made by hand and the cutter lowered into it. The form of the working breast may be either a uniform cut of any slope, or the arc of a circle, depending on the raising or lowering of the controlling boom as the scoop is drawn upward. The cable which operates the cutting beam is attached near the scoop, thus permitting a powerful and direct pull to be exerted on the latter.

In a letter to the writer, the inventor of this machine, Mr. J. W. F. Stephens of New Orleans, La.,

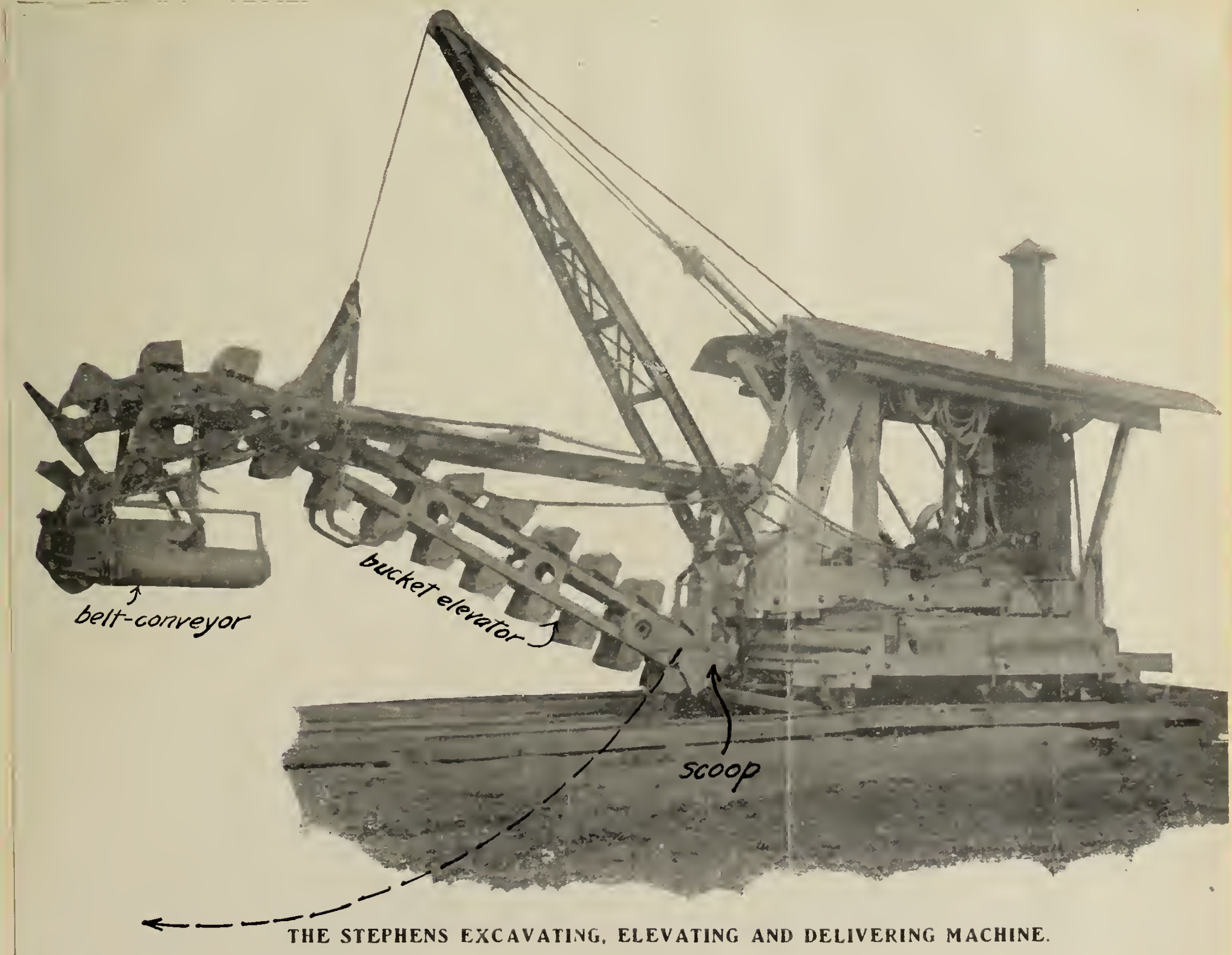
states that on some work at New Orleans, from 25 to 30 cu. yds. per hour have been excavated with it in a trench 26 inches wide and 8 to 10 feet deep, the material being a plastic clay with many buried cypress stumps. The limits of width and depth cut by this machine are respectively 44 inches and 15 feet. Boiler and engine are each about 18 H.P. tho' these can be replaced by some of greater power. As in the other excavating machines, this one also is supported on the solid ground in advance of the trench, running on a light track. The entire weight is about 15 (?) tons.

A distinct advantage possessed by this machine is that any double-drum hoisting crane of 3 or 4 tons capacity, may be transformed into an excavator by attaching the controlling boom and cutting beam of this machine to it, with a sprocket wheel added. The Stephens attachments can be easily removed when desired.

As this machine is still very new, and has not been tested outside of New Orleans, it is impossible to give any further data on

it; but the writer firmly believes that it will cut its way to a place among other successful machines.

A drainage machine, somewhat similar to the "Buckeye" was manufactured at Streator, Ill. about 1885. It was called the "Plumb", but has long since been generally forgotten.



THE STEPHENS EXCAVATING, ELEVATING AND DELIVERING MACHINE.

(SEWER TRENCH TYPE.)

Fig. 18.

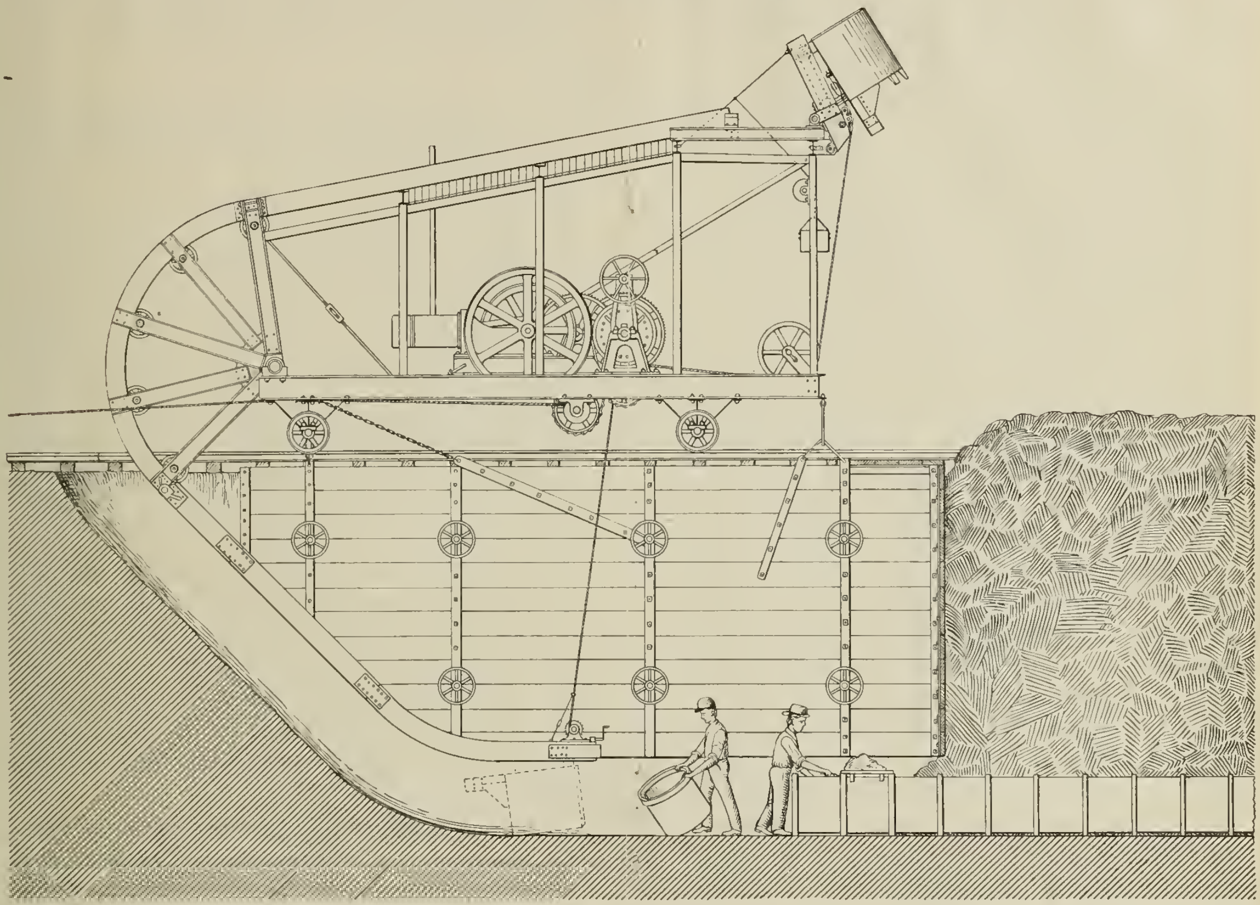
III. Excavating and Backfilling Machines.

It would appear that machines of this type, i.e., those which dispose of the material in a single continuous operation, are the most desirable. Tho' auxilliary backfilling attachments are used with excavating machines as described above, there is, so far as the writer knows, only one make of machine which does both excavating and backfilling.

The Libbe Digging Machine.

This machine is built by the Libbe Engineering and Construction Co. of Toledo, Ohio, and is called The Libbe Digging Machine. The digging device consists essentially of a toothed dipper, which is drawn upward along the working breast of the trench by means of an attached cable. This dipper or bucket is mounted on a set of small wheels which travel on the flanges of steel channels. The depth cut is regulated by the position of the runway, which as seen in Fig. 19, is lowered into the trench, and extends over the top to the rear end of the machine. The upper and lower

The Libbe Digging Machine



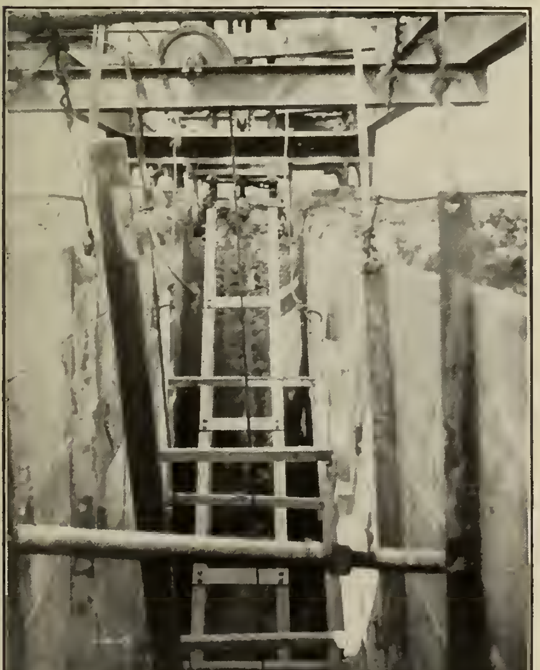
Side Elevation of the Machine, Showing the Trench

Fig. 19.

legs of the runway are connected by a curved portion of about 15 foot radius, so that the bucket is righted immediately upon leaving the trench. Both legs are inclined as shown, so that the buckets will not lose its contents, and also so that it may return by gravity when emptied. At the end of the upper leg

of the runway is a pivoted section which is tilted by the loaded dipper coming upon it, thus dumping the material. As soon as the bucket is emptied, the pivoted section is returned to its normal position by a counterweight, and the bucket returns by gravity to the bottom of the trench.

A steel frame about 30 feet long mounted on wheels, carries the runway and necessary bracing. From this frame is also suspended a patent sheeting which is held in place with ordinary trench braces, - see Fig. 20 - and is moved forward with the machine. This serves as a continual protection to the workmen who may be in the trench, and thus permits the work of laying water, gas or sewer pipes as the excavation and backfilling proceed. Midway in the machine is mounted a steam engine of from 20 to 40 HP which furnishes the power for



Showing Trench Dug by the Libbe Digging Machine

Fig. 20.

drawing up the dipper. As above stated, the entire machine is mounted on wheels. These run on a track placed astraddle of the trench, and the machine, being attached to an anchored cable, is pulled ahead by the engine.

Instead of backfilling into the trench, the runway can be adjusted so as to deposit the earth on either side when it is desired to leave the trench open. The shipping weight of the complete machine is about 10 tons.

As this machine has been in use only about two years, it is difficult to secure any great amount of data as to its speed and cost of operation. In a letter to the writer, the manufacturers say: "The best work this machine ever did was a trench 15½ feet deep and 61 feet long in 3 hours, though we have made a number of short runs at a greater speed. This was with a 36-inch bucket making a 38-inch trench." It is claimed that the machine will excavate 1 cu. yd. per minute, and it is guaranteed to do so in 2 minutes in "ordinary" soil. This would make the capacity of the machine from

30 to 50 cu. yds. per hour. "Three men only are required to operate the machine, and the expense should not be over \$10.00 a day for everything." The largest size trench that can be dug is one 3 feet wide by 30 feet deep, the width of the digger being adjusted to the desired width of the trench.

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4-24-'05.